THE ROLE OF PUBLIC HEALTH AGENCIES IN ADDRESSING CLIMATE CHANGE AS A HUMAN HEALTH CONCERN

Thesis

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ABSTRACT

With global average temperatures and average sea levels rising, an increased occurrence of extreme weather events, and losses in biodiversity, climate change has become increasingly evident in the scientific community. A relatively new issue, however, has been the linkage between climate change and its effects on human health; with extreme weather events occurring more frequently and with increased severity, water resources, food resources, and human lives are at stake.

Although discussing climate change within the context of human health is relatively new, public health agencies must become aware of these potential impacts in order to properly protect their jurisdiction. In order to analyze the underlying factors that influence attitudes towards climate change and health among public health professionals, the research presented in this thesis involved a survey of Environmental Health (EH) Directors across the country. EH Directors within public health agencies are assumed to be responsible for addressing the health-related issues predicted to be affected by climate change. The survey also evaluated whether or not an EH Director's department is addressing, or plans to address, the health related impacts of climate change.

This study examines attitudes and decision behaviors in two parts: First, the factors that influence EH Directors' attitudes towards climate change were evaluated by assessing respondents' environmental attitudes, gender, and political ideology. It was found that out of the three independent variables, environmental attitudes and political ideology made strong, unique contributions in explaining EH Directors' attitudes towards

climate change. Second, the study looks at what factors influence climate change adaptation behavior within an EH Department. Out of all of the independent variables analyzed, EH Directors' perception of the risk posed by climate change played the largest role in determining whether or not the EH Departments had programmatic activities that addressed climate change adaptation. Resource issues, including funding, staffing, and training, also appear to influence whether or not an EH Department addressed the health-related impacts of climate change.

In order to prepare public health agencies for climate change, additional resources will be needed. These resources include funding for local health impact assessments, staff, and training. At the same time, EH Directors must perceive the health risks posed by climate change as real, local threats. Further research is needed on the exact extent that climate change will impact human health, including data on the specific local health impacts that will affect each department's jurisdiction.

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PURPOSE OF STUDY

Since it has been found that climate change can and probably has had an impact on human health (Confalonieri, et al., 2007), this research project investigates how much Environmental Health (EH) Departments across the country actually know about these findings, and whether or not they agree. Most importantly, this project investigates whether EH Departments are prepared, or at least willing to prepare, to deal with this concern. Finally, this project provides clues for the next steps needed to help EH Departments address the climate change issue, and therefore help educate the public on how to promote their own health and prosperity in light of climate change. For example, if EH Directors do not think that climate change has impacts on human health, or that their department should not be responsible for addressing the issue, then this would be of concern; most climatologists agree climate change is a serious human health issue that needs to be addressed (Confalonieri, et al., 2007; Patz, et al., 2004). If EH Departments spend a portion of their budgets to address the health impacts of climate change, they can help prepare their jurisdiction for any impacts that could specifically affect their area, such as extreme weather events, food insecurity, and/or outbreaks of infectious disease.

CHAPTER 1: BACKGROUND ON CLIMATE CHANGE AND ITS IMPACTS

1.1 Evidence of a Changing Climate

Throughout the past few decades, scientists have observed some remarkable changes in our climate. As a result, climate change has become an issue of increasing concern around the world. For example, scientists found that the Earth's average temperature is rising. These warmer climatic conditions have had a direct impact on Alpine glaciers, which have lost over 33% of their surface area and over 50% of their volume in the 20th century (Saunders, 1999). The IPCC projects that the rising temperatures will only get worse (Figure 1.1)

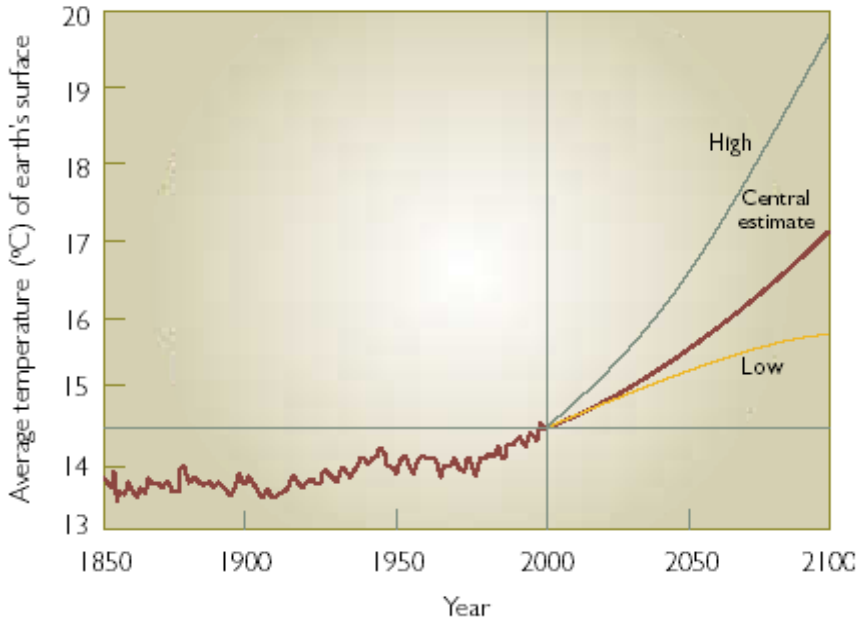

Figure 1.1: Global temperature record, since instrumental recording began in 1860, and IPCC projection to 2100 (IPCC, 2001)

It has also been found that extreme weather events, including increased amounts of precipitation (Curriero, et al., 2001), are occurring more frequently and with more severity (Saunders, 1999). Scientists have also discovered that the average sea level rose at an annual rate of 1 – 2 mm in the 20th century (Ebi, Mearns, & Nyenzi, 2003). These climatic changes can lead to severe problems for the natural environment, as well as for human health (Patz, et al., 2000), all of which will be discussed in further sections.

1.2 Anthropogenic Climate Change

Recently, scientists and policy makers have begun to analyze the impact that humans have had on these climatic changes. The Intergovernmental Panel on Climate Change (IPCC), a scientific intergovernmental body set up by the World Meteorological Organization (Githeko & Woodward, 2003), released an assessment report in 2001 regarding human contributions to climate change. The report indicates that there is strong evidence attributing global warming over the last fifty years to human activities (IPCC, 2001). The panel concluded that, since the pre-industrial era, human activities have increased the concentration of greenhouse gases (GHG) in the atmosphere (IPCC, 2001).

Greenhouse gas emissions can be very detrimental to the environment. These atmospheric gases trap heat and prevent it from escaping the earth's atmosphere, resulting in an increased warming of the earth (Saunders, 1999). Although there is a natural greenhouse effect, climatologists have shown that humans have dramatically

increased GHG levels, especially through agriculture, deforestation, and the combustion of fossil fuels (Saunders, 1999). In fact, levels of GHG have been rising every year since detailed records started being kept in 1958. In 2008, GHG in the atmosphere reached record highs (CBC News, 2009).

The major GHG of concern is carbon dioxide, because it can persist in the atmosphere for hundreds of years (Saunders, 1999). Data indicates that the levels of carbon dioxide in our atmosphere continue to increase (Ebi, et al., 2003). By 2100, concentrations of carbon dioxide in the atmosphere are expected to be between 490 – 1260 parts per million, resulting in an increase between 1.4 – 5.8˚C in the global mean temperature. However, other publications conclude that these anticipated levels are more conservative, and that by 2100 the concentrations of carbon dioxide in the atmosphere will actually be larger than between 490 – 1260 parts per million (Ebi, et al., 2003).

Since carbon dioxide is released into the atmosphere from a variety of anthropogenic causes, and it has been proven to have a significant effect on the atmosphere and climate change, steps can be taken to decrease our impact (IPCC, 2001). As a result, there has been a significant movement in the environmental community to help decrease the level of GHG emitted into the atmosphere by humans, and therefore decrease the anthropogenic causes of climate change (Warrick & Farmer, 1990).

1.3 Impacts of Climate Change

1.3.1 Environmental Effects

Since scientific evidence of human contributions to climate change have been identified and publicized, many interested groups have attempted to influence people's perceptions on the issue in order to push for change. Emphasis has been placed on how humans have affected the habitats and lives of various wildlife species (McMichael, 2003). For example, human demand for land and resources has led to the loss of many species of plants and animals (McMichael, 2003). Wildlife habitats in arctic regions are changing greatly as a result of increased temperatures that are reducing the amount of ice in the region. Since all animals in an ecosystem are interconnected, a change in one species may result in dramatic changes throughout the food chain. By decreasing our impact on climate change, we could potentially help restore the habitats that thousands of species depend upon for survival (McMichael, 2003).

Although climate change affects plant and animal species, there is growing evidence over the past ten years indicating that climate change affects human health as well (Githeko & Woodward, 2003). Research within this area has been especially challenging, because climate change is just one environmental change that affects health; it is often hard to separate climate change's impact from other possible changes, such as population dynamics and density (Githeko & Woodward, 2003). However, alterations in climate are believed to influence several factors that in turn influence human health. Each of these health concerns is summarized in Figure 1.2, and each will be discussed in more detail in the following sections.

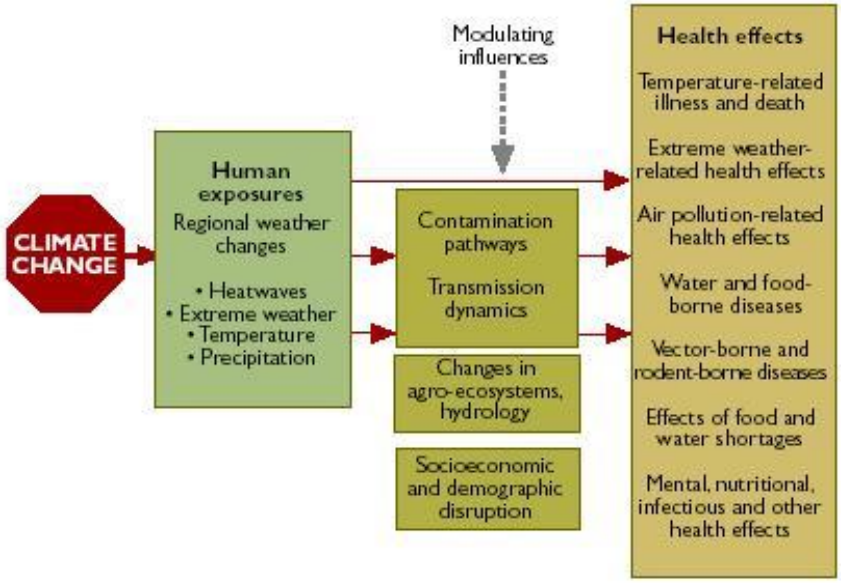

Figure 1.2: Predicted ways that climate change impacts human health (WHO, 2010).

1.3.2 Air Quality

As concentrations of GHG increase in our atmosphere, the quality of air decreases (Weare, 2002). Ground-level ozone, which is formed by a combination of warm, polluted air and sunlight, is expected to increase as a result of climate change; ozone can damage the lungs and exacerbate respiratory problems. In the U.S., climate change is especially likely to increase ground-level ozone concentrations in northeastern, midwestern, and western cities (CDC, 2009). Temperature increases will exacerbate the problem, because an increase of approximately 5°C can double the maximum daily ozone concentration in some areas (Weare, 2002).

1.3.3 Injury or Death from Extreme Weather

With increased temperatures as a result of climate change, cases of severe heat strokes are more likely to occur as well. Since 1950, heat waves in the U.S. have

increased threefold; today, heat waves kill more people in the U.S. than hurricanes, tornadoes, lightning, and blizzards combined (Kent & DeLeo, 2006), with an average of about 1000 deaths per year. The 1995 heat wave in Chicago, Illinois is an important example that displays exactly why heat waves are a critical health issue in our country; approximately 525 people died after a five-day period of high humidity and temperatures reaching up to 106°F. Most of the victims from the weather-related disaster were poor and/or older citizens (Angel, 2008).

The increase of other extreme weather events, such as hurricanes, could also put many lives at risk (Patz, et al., 2000). The IPCC predicts with a high degree of confidence that trends in climate change related to human health will increase the number of people who suffer from heat waves, floods, and other extreme weather events (Confalonieri, et al., 2007). In the U.S., this is especially a concern for urban areas where many people are congregated in one exposed location (Longstreth, 1999).

1.3.4 Water and Food Issues

Extreme weather events can have detrimental effects on our water and food resources as well. Increased levels of rainfall can cause storm water to overload a municipal sewer system or treatment plant, resulting in excess wastewater discharging directly into our water resources. Also, when extreme precipitation leads to increased runoff, microbiological agents can be more readily transported into sources of drinking water (Githeko & Woodward, 2003). With as many as nine million cases of waterborne disease outbreaks estimated to occur each year in America (Rose, et al., 2001), waterborne disease is a critical concern within our country. For example, in 1993,

increased precipitation and runoff in Milwaukee helped contribute to the largest reported waterborne disease outbreak documented in the United States; there were approximately 403,000 cases of illness and 54 deaths as a result of the outbreak (Curriero, et al., 2001).

A previous study compared data on water-borne disease outbreaks between 1948-1994 to precipitation data from the same time period. These researchers found that there was a very strong association between extreme precipitation events and water-borne disease outbreaks caused by surface water contamination (Curriero, et al., 2001). For example, after Hurricane Katrina and Hurricane Rita, water supplies were contaminated with fecal bacteria, causing many cases of diarrheal illness and even some deaths (Confalonieri, et al., 2007). With precipitation found to be on the rise as a result of our changing climate, Americans must also consider the impact it will have on their health (Curriero, et al., 2001).

Similarly, food-borne diseases are expected to increase, both within the United States and abroad (Frumkin, et al., 2008). Higher temperatures often cause increases in the replication, survival, and transmission of bacterial pathogens (CDC, 2009), such as *Salmonella (*Confalonieri, et al., 2007). Similarly, parasitic infections are also expected to increase due to higher temperatures creating more favorable conditions (CDC, 2009).

Food resources themselves are very sensitive to extreme weather as well. Increased precipitation, droughts, and floods can all affect our global food supply; it is predicted that droughts will lead to food shortages and malnutrition (Frumkin, et al.,

2008). Although a warmer climate is expected to benefit food production in some areas in the United States, other regions are predicted to endure significant losses, especially those that are already near climate thresholds (Field, et al., 2007).

1.3.5 Vector-borne Disease

Increased temperatures and precipitation also increase ideal breeding grounds for many vectors that transport diseases to humans. Consequently, in addition to food- and water-borne diseases, an increase in vector-borne diseases should also be considered (Frumkin, et al., 2008). Climate change can increase the population of a specific vector of a disease by increasing the number of suitable habitats for that vector to breed, or by extending the seasonality for reproduction (Chan, et al., 1999).

Although largely a concern for developing countries, this issue is of great importance in developed countries as well. The outbreak of West Nile Virus in the U.S. helps reaffirm the concern that Americans should have with vector-borne disease (Ebi, et al., 2003). At the same time, other vector-borne infectious diseases are of increasing concern in America. For example, it is believed that climate change is responsible for the increased population of two new mosquito species that live in the United States (Hamburg, et al., 2008). These two species, which thrive in humid weather, are believed to be carriers for a variety of diseases, including yellow fever, dengue fever, and West Nile Virus. Currently, these two species of mosquitoes live in more than thirty states across the country (Hamburg, et al., 2008).

Also, many rodents, such as those that can pass Hantavirus pulmonary syndrome (HPS), breed in hot weather. HPS is a potentially deadly disease that is passed simply

by inhaling airborne particles from rodent feces (Hales, et al., 2003). Between 1999-2000, there were 231 cases of HPS in America, and the disease had a mortality rate of 42% (Patz, et al., 2000).

In one study, researchers used geographic information on rodent habitats in Texas to predict the impact global climate change would have on rodent species' populations and their geographic ranges. Researchers found that warmer, dryer climates in western and southern Texas generally increased specific species of rodent populations. An increase in rodent populations, which is expected to occur to some extent as a result of climate change, increases the likelihood of disease (Cameron & Scheel, 2001).

1.3.6 Mental Health

On top of these physical health issues posed by climate change, mental health problems are also a concern. For example, exposure to severe trauma and resource loss (such as injury, death, financial hardship, and damage or loss of homes) has been shown to almost double the rate of mild to moderate common mental disorders. Such trauma and loss is likely to increase as a result of severe weather. These psychological impacts from severe weather are most recently evident in Hurricane Katrina victims. One study reported that attempts at self-harm and the prevalence of post-traumatic stress disorder among Hurricane Katrina victims increased over time, even two years after the hurricane (Chand & Murthy, 2008).

1.4 Disparities among Different Regions

Depending on several factors, such as where warmer weather is more likely to occur, some regions may be more affected by climate change than other regions. For example, severe drought caused by higher temperatures would prevent many disease vectors from being able to breed in those specific areas (Patz, et al., 2000). However, these locations could have more issues with food security than other areas. At the same time, regions may also be disproportionately affected depending on the percentage of susceptible populations residing in that area (Longstreth, 1999). Vulnerable populations include the elderly, the young, and the poor, all of which are more susceptible to climate-related health issues; the elderly suffer from loss of immune-related functions, the young suffer from not gaining these functions yet, and the poor suffer from lack of resources and health care (Longstreth, 1999). It has also been found that populations living in areas that have a longer summer have a greater risk of climate-related diseases than those populations that have a shorter summer (Longstreth, 1999).

1.5 The Role of Public Health Agencies

The previously mentioned findings suggest that climate change will affect human health in America, and some researchers believe to some degree it already has (Balbus, et al., 2008). As a result of these findings, public health agencies should establish interventions to address the health-related issues of climate change (Corvalán, et al., 2003). Since public health agencies communicate to the general public, across all professions and backgrounds within their jurisdictions, they could be

important resources and leaders in the effort to prevent or lessen the harmful health impacts of climate change (Greer, et al., 2008). Not only could agencies protect the public through their policies, but they can also serve as a credible source to educate the public on these issues (Dilling & Moser, 2007).

Creating climate change programs within public health agencies is challenging to achieve, because data on how climate change can affect health are new and the exact extent of its impact continues to be explored. However, since there is evidence that links climate change to human health, public health agencies should not avoid taking action (Corvalán, et al., 2003). Leiserowitz (2007) explains, "...scientific uncertainty alone is not an adequate justification for inaction or business-as-usual. Rather, it suggests that, at a minimum, it would be prudent to...adopt adaptive management strategies" (p. 56-57).

The public health community should be aware of this growing issue in order to effectively establish preparedness plans to help prevent, or at least decrease the chances of, severe health impacts caused by climate change (Balbus, et al., 2008, Patz, et al., 2004). Similarly, certain aspects of the current public health infrastructure need to be strengthened in order to properly address climate change, including disease surveillance, food and water safety monitoring, insect vector and animal reservoir regulation, and disease-outbreak response (Greer, et al., 2008).

1.6 Past Research on Actions Taken by Public Health Agencies

Recently, there has been a growing interest in assessing current programs within public health agencies in order to determine their level of preparedness against climate change impacts. In 2008, the National Association of County and City Health Officials (NACCHO), the Environmental Defense Fund, and George Mason University conducted the first national survey to assess local Public Health Directors' views about climate change and its impacts on health. The survey also looked at whether the directors' public health department had taken action to address these issues. Also, the survey asked Public Health Directors about what constraints they felt held them back from incorporating climate change into their programs (Wexler, Dickson, & Laskowski, 2008).

The survey, conducted by telephone interviews, randomly sampled 27 local health department directors. Although the majority of respondents perceived climate change as a health threat within their jurisdiction, only 19% stated that climate change was one of their department's top ten priorities. In addition, although about two-thirds of the respondents felt that they were knowledgeable about the potential health-related impacts of climate change, less than half thought that other important senior managers within their department were similarly knowledgeable. Moreover, more than 80% of directors felt that their department lacked the expertise to create effective adaptation and mitigation plans. The study concluded that local public health directors have only begun to identify climate change related risks and execute policies to reduce current and future impacts of climate change; the main constraint that explained the

departments' inaction was a lack of human and financial resources (Balbus, et al., 2008).

In 2009, the Association of State and Territorial Health Officials (ASTHO) conducted a survey analyzing the same concerns, but instead looked at state and territorial health department directors. The e-mail survey received 43 responses from various states and territories. Consistent with the NACCHO survey, although the majority of health officials stated that climate change would result in serious health problems, most respondents did not consider climate change to be one of their top ten priorities, mainly because of a lack of resources and sufficient expertise to respond appropriately (Sinclair, 2009).

Although these surveys provide useful information on Public Health Directors' views and their current policies on climate change, there are several gaps in the current data. For example, neither survey asks other senior management officials, such as Environmental Health (EH) Directors, about their views on climate change, and what their division has done to address it. EH Departments within a public health agency handle issues related to air quality, food-borne, water-borne, and other infectious diseases; as a result, their actions are critical for protecting against the health-related impacts of climate change. If EH Departments become aware of these climate-related health issues and see them as a threat, then more action might be taken to protect human health.

Unfortunately, there is little to no published literature indicating whether or not EH Departments at the local, state, and territorial agency levels have actually implemented

climate change into their department's planning, nor is there literature suggesting that EH Directors even know about the detrimental effects climate change can have on human health. More research is needed to assess where these departments stand on the issue, and whether or not they are prepared to deal with the large array of potential public health consequences of climate change.

To address this gap in research, the study reported here identifies EH Directors as the main population of interest. The study focuses on eliciting EH Directors' knowledge, attitudes, and perceptions of risk about the health-related impacts of climate change. This study will also assess respondents' levels of efficacy and perceived responsibility; more specifically, it examines whether or not EH Directors think they can make a positive difference by addressing climate change, if their department is able to address climate change, and if EH Directors even believe it is a part of their job responsibilities to do so. These variables might help to explain whether or not EH Directors have decided to take action to address climate change within their department. Moreover, this study addresses correlations between the above variables and specific socio-demographic variables, including gender, education, and political ideology, in order to better understand EH Directors' views and the choices that they have made. The premise of this study is that if we can identify why EH Departments have or do not have climate change programs, then we can more effectively promote the development of these policies in health departments across the country.

CHAPTER 2: THEORETICAL BACKGROUND ON ATTITUDES AND BEHAVIOR

2.1 What Influences Attitudes towards Climate Change?

The word "attitude" has been difficult to clearly define, especially since it is a construct that cannot be directly seen or observed. In social psychology, an attitude is defined as an affective dimension that results in evaluations of an object or entity as either favorable or unfavorable (Jaccard & Blanton, 2007). In order to better understand why Environmental Health (EH) Directors have made choices in addressing or not addressing climate change within their department, it is necessary to first assess certain interrelated factors that this study hypothesizes influence their attitudes towards climate change. The factors that are believed to influence attitudes to climate change include attitudes towards the environment, knowledge, and several socio-demographic variables (e.g., educational background, political ideology, and gender) (Figure 2.1).

2.1.1 Attitudes towards the environment

When looking at an individual's attitudes specifically towards climate change and how it affects their environmental behaviors, it is helpful to first assess their general attitudes towards the environment (Dunlap, et al., 2000). In 1978, Riley Dunlap and Kent Van Liere publicized their New Environmental Paradigm Scale, which was used to assess respondents' level of concern for the environment. In the 1990s, the scale was revised, improved, and termed the New Ecological Paradigm (NEP) Scale. The revised NEP Scale is similar to the original, but it contains several key improvements; the revised NEP Scale has three additional statements, more internal consistency, and it

gives a better balance between pro and anti-environmental statements (Dunlap, et al., 2000).

Research shows that a high score on the NEP Scale, which is interpreted as a more pro-environmental viewpoint, should also parallel attitudes towards specific environmental issues, such as global climate change (Dunlap, et al., 2000). A study by Leiserowitz (2007) found that respondents who expressed anti-environmental attitudes predominantly perceived climate change as a very low or non-existent danger. Likewise, another study found that individuals with pro-environmental attitudes were significantly more willing to support efforts to reduce GHG (O'Connor, et al., 2002), thereby indicating negative attitudes towards climate change.

2.1.2 Knowledge

Previous research has looked at whether or not knowledge can influence behavior. Studies have shown that those who can obtain and understand information the most are more inclined to change behavior (Tribbia, 2007); without knowing about the problem and the possible solutions to address it, there is little incentive to act. As Grotzer and Lincoln (2007) explain, "We need to help the public develop the ability to understand climate change but also the sensitivity to perceive opportunities that invite action…" (pp. 268).

However, knowledge about climate change issues and actions is not nearly enough to affect behavior change, and people often view the mere act of obtaining information as having acted on the problem (Tribbia, 2007). Studies show that the knowledge-deficit theory, which states that increasing knowledge will lead to a change

in behavior, is not very useful for explaining behavior (Hansen, et al., 2003; Kellstedt, Zahran, & Vedlitz, 2008; Schultz, 2002). Dilling and Moser (2007) explain this by stating, "While we strongly believe that better understanding has an important role to play, communication that does not keep barriers to behavior and social change in mind is unlikely to be effective or sufficient" (pp. 11).

Although previous studies have indicated that knowledge does not significantly affect behavior, it has been shown to be an influential component of information seeking and processing. Kahlor (2007) explains that the amount of information one seeks is mainly determined by personal perceptions of the need, accessibility, and usefulness of the information. Griffin, Dunwoody, and Neuwirth (1999) state, "…the perceived gap between what someone knows and what he or she needs to know motivates a person to devote more cognitive effort to processing messages about the behavior" (pp. S237).

Knowledge has also been shown to influence an individual's attitudes (Arcury, 1990). For example, a study found that biology students, who had more knowledge about nature than students who were not in the class, were more likely to have positive attitudes towards the environment (Tikka, Kuitunen, & Tynys, 2000). Due to this belief about knowledge affecting one's attitudes, this project specifically analyzes how knowledge about climate change and its health-related concerns affects EH Directors' attitudes towards climate change.

2.1.3 Socio-demographics

Finally, there are several underlying socio-demographic factors that have been shown to influence an individual's attitudes (Diamantopoulos, et al., 2003; Kollmuss &

Agyeman, 2002). These factors include age, education, race, location, gender, and political affiliation, among other things. This study specifically analyzes how EH Directors' level of education, gender, and political ideology correlate with their attitude towards climate change.

The Leiserowitz (2007) study discussed earlier found that those who felt climate change was a very low or non-existent danger were predominately male and politically conservative. On the other hand, those who thought climate change was a serious issue were mainly politically liberal, and females tended to see climate change as a greater hazard than males. A different article on the same study also explains how females and liberals were more likely to support national policies to address climate change, whereas conservative males were more likely to oppose these policies (Leiserowitz, 2006). Other studies have also found that liberals were more likely than conservatives to favor actions to address climate change (Lorenzoni, Pidgeon, & O'Connor, 2005; Patchen, 2006). Politically liberal individuals often have a significantly higher pro-environmental rating on Dunlap's NEP Scale as well (Slimak & Dietz, 2006).

As the Leiserowitz (2007) study shows, gender has been found to be an important predictor of attitudes (Diamantopoulos, et al., 2003; Kollmuss & Agyeman, 2002; Leiserowitz, 2006). Although there is no one correct hypothesis as to why females tend to view climate change more negatively than males, a common belief is that women are socialized to nurture and maintain life, and thus are more concerned about health and safety (Slovic, 1999). Similarly, women have been shown to engage in environmentally friendly behaviors more than men (Tribbia, 2007).

There are contrasting views on how education influences people's attitudes towards a risk (Patchen, 2006). However, past research has shown that individuals with a higher education level have more knowledge on environmental issues (Diamantopoulos, et al., 2003; Kollmuss & Agyeman, 2002). Therefore, this study specifically looks at whether or not one's educational background *indirectly* affects their attitudes towards climate change by increasing their knowledge about climate change and its impacts.

2.2. What Influences Behavior?

The factors described previously all help to explain what influences an individual's attitudes towards climate change, and what indirectly influences behavior through attitudes. The factors that more directly influence whether or not an EH Director has addressed or plans to address climate change within their department include attitudes toward climate change action, as well as their perception of climate change as a risk (Leiserowitz, 2005). Department (self) efficacy, response efficacy, perceived responsibility, and outside barriers have also been shown to affect choices and will also be discussed (Leiserowitz, 2006).

2.2.1 Attitudes towards climate change action

Attitudes towards objects, or entities like climate change, can predispose individuals towards behavior (Jaccard & Blanton, 2007). As a result, this study will look at how attitudes towards climate change, the entity, specifically affect EH Directors' attitudes towards addressing climate change within their departments. According to social psychologist Icek Ajzen, attitudes towards a behavior are defined as the degree

to which performing the behavior is positively or negatively valued (2004). Using this definition, it is evident that attitudes play an important role in the choices that people make, depending on how they value performing the specific behavior. Attitudes towards environmental factors have been shown to influence attitudes towards certain environmental behaviors (Diclemente & Crosby, 2002; Dunlap, et al., 2000).

A study conducted in Denmark found that respondents who had pro-environmental attitudes were more likely to buy organic food (Grunert & Juhl, 1995); therefore, the inference is that respondents with pro-environmental attitudes had more positive attitudes towards buying organic food. Similarly, another study found that individuals exhibiting pro-environmental attitudes were more likely to approve of policies that promoted the environment (Kim & Choi, 2003). For this reason, just as past research has shown how attitudes towards the environment can influence attitudes towards environmental behaviors, this project will test how attitudes towards climate change affect attitudes towards actually addressing the issue. Also, the study will look at how attitudes towards action influences whether or not EH Directors have actually addressed climate change within their departments.

However, it is important to note that pro-environmental behavior does not just occur through one's attitudes towards the behavior; there are other factors that can influence behavior as well (Diamantopoulos, et al., 2003; Dunlap, et al., 2000). These other factors will be discussed further in the sections below.

2.2.2 Risk Perception

Risk is defined as, “the likelihood that an individual will experience the effect of danger” (Sjöberg, Moen, & Rundmo, 2004). In contrast, risk perception is the *personal* assessment of the probability of a specific event happening, and how concerned one is with its consequences (Sjöberg, Moen, & Rundmo, 2004). Like attitudes, risk perception can help predict why people behave the way that they do (O’Connor, Bord, & Fisher, 1999).

The important role of risk perception in affecting behavior can be seen with society’s current views on climate change. One study showed that the majority of Americans think climate change is a somewhat to very serious problem, but most only perceive it as a moderate risk that will mainly impact other, distant geographical locations (Leiserowitz, 2005). The same study also found that many Americans do not associate climate change with human health, with 38-41% of respondents stating that they did not know what the present and future health effects from climate change would be (Leiserowitz, 2005).

Public risk perceptions are vital elements in the development of climate change policies; since climate change often lacks a sense of personal risk and urgency, it is a lower priority than other national issues. If Americans do not begin to view climate change as a current, local threat that can potentially impact their health and well-being, then the risk will not fully be perceived, and efforts to change behavior will be much more challenging (Leiserowitz, 2007; Moser & Dilling, 2007). This study specifically looks at the way EH Directors perceive the health risks from climate change, and if the

perceived risk influences whether or not they implement climate change adaptation programs within their departments.

2.2.3 Efficacy

Another important factor that influences behavior is self-efficacy, or perceived behavioral control. This concept refers to how much an individual believes he or she is capable of performing a certain action (Ajzen, 2004); even if an individual knows about climate change, thinks that it exists and poses a threat to their own well-being, they may not be motivated to act if they feel that they don't have the ability to address it. For example, a study found that high school students were more likely to engage in environmentally responsible behaviors when they had a strong sense of self-efficacy in being able to positively impact the environment (Meinhold & Malkus, 2005; Patchen, 2006). This study analyzes EH Directors' views about their department's efficacy in being able to address the health impacts of climate change.

Similar to self-efficacy is response efficacy. Response efficacy is the degree to which a behavior is perceived to be effective at reducing a certain risk (Martin, Bender, & Raish, 2007). Kaplan's Responsible Person Model explains that individuals are motivated to learn and understand what is going on, but they avoid situations where they feel they cannot make a difference (Kaplan, 2000; Tribbia, 2007). Thus, Kaplan (2000) explains helplessness as, "one of the most important motivational issues to consider in the context of behavior change" (pp. 498). A survey conducted by the Pew Research Center for the People and the Press found that although the majority of Americans think that climate change is happening, over one in five of these respondents

stated that it was impossible to reduce the effects of climate change (Patchen, 2006; Pew Research Center, 2006). For this study, if EH Directors do not think that addressing climate change as a health issue within their department will reduce its health impacts, they would exhibit a low response efficacy to this risk-mitigation behavior. Thus, it is expected that EH Directors with low response efficacy would be less likely to incorporate climate change programs within their department (Tay, Watson, & Radbourne, 2001).

2.2.4 Perceived Responsibility

Individuals are also more likely to act in environmentally responsible ways if they believe it is their obligation to do so (Kellstedt, Zahran, & Vedlitz, 2008). This behavior could occur for several reasons, including the desire to seek approval from important people such as peers and superiors (Tribbia, 2007). As Tribbia (2007) explains, "As a participating role player, the individual is strongly influenced by community expectations or wider social expectations" (pp. 246). This study looks at whether or not an EH Director's perceived responsibility affects their department's behavior in addressing the health impacts of climate change.

2.2.5 Outside Barriers to Behavior

Barriers to behavior do not just include the internal motivations discussed above. Other constraints within an EH Department could be outside of an EH Director's control, such as resources like time, staff, and money; although EH Directors may view climate change as an issue that they can and want to address within their department, they may be forced to refrain from acting on their personal beliefs due to these outside

constraints. As stated in Chapter 1, the NACCHO and ASTHO surveys sent to Public Health Directors identified a lack of resources, particularly staff and money, as the main constraints to behavior (Balbus, et al., 2008; Sinclair, 2009). This study will identify any outside resource constraints that EH Directors feel are needed in order to address the health impacts of climate change.

CHAPTER 3: METHODS

3.1 Developing the sampling frame

The sampling frame consists of Environmental Health (EH) Directors at local, state, and territorial public health agencies across the country. Since EH Directors manage the department's environmental health issues regarding air, food, water, and infectious disease, the study assumes that EH Directors represent the public health workforce in regards to the health-related impacts of climate change. The sampling frame was developed by using the internet to find all public health agencies across the country that had an appointed EH Director listed on their website; the appropriate individual's address, phone numbers, and exact position title was collected on a spreadsheet. A total of 823 e-mails were sent out, and 191 full responses were received, thereby totaling a 23% response rate.[1] When including the partial responses that were also received, there were approximately 220 responses.

3.2 Research Questions

There are several research questions that are the focus for this study:

1) **What influences EH Directors' attitudes towards climate change?**
2) **Are Environmental Health departments addressing the health impacts of climate change? Why or why not?**

[1] There are approximately 2,353 public health agencies across the country; however, it is unknown how many of these agencies actually have an EH Department.

3.3 Hypotheses

The following hypotheses are based on a review of the literature regarding attitudes and behavior. The first set of hypotheses focuses on five predictor variables (i.e., educational background, political ideology, gender, knowledge, and environmental attitudes), and how they relate to one dependent variable (i.e., attitudes towards climate change). The relationships posed by the following hypotheses are visually depicted in the model proposed in Figure 3.1. The first set of hypotheses is:

H1a) The more educated EH Directors are, the more knowledgeable they will be about climate change and its health impacts.

H1b) The more politically liberal EH Directors are, the more positive their attitudes towards the environment.

H1c) The more politically liberal EH Directors are, the more negative their attitudes towards climate change.

H1d) Female EH Directors are more likely than males to have a positive attitude towards the environment.

H1e) Female EH Directors are more likely than males to have a negative attitude towards climate change.

H1f) The more knowledgeable EH Directors are about climate change and its impacts, the more negative their attitudes towards climate change.

H1g) The more positive EH Directors' attitudes towards the environment, the more negative their attitudes towards climate change.

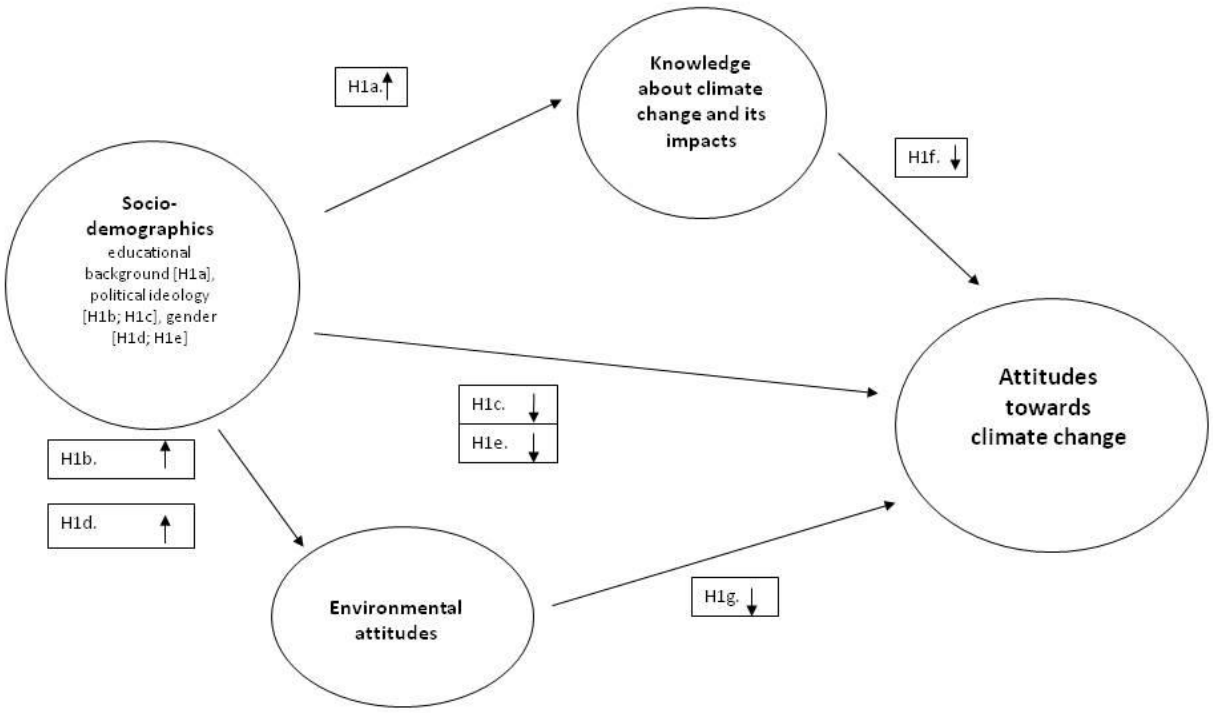

Figure 3.1: Hypothesized correlations (where an arrow pointing up conveys a positive correlation while an arrow pointing down conveys a negative correlation) and independent variables expected to directly influence attitudes towards climate change in the regression model

The second set of hypotheses focuses on six different predictor variables (i.e., attitudes towards climate change, attitudes towards action, risk perception, response efficacy, department (self) efficacy, and perceived responsibility), and how they relate to one dependent variable (i.e., current and/or future climate change adaptation programs within an EH Department). The relationships posed by the following hypotheses are

visually depicted in the model proposed in Figure 3.2. The second set of hypotheses is:

H2a) As EH Directors' attitudes towards climate change become more negative, their attitudes towards pursuing climate change action within their EH departments become more positive.

H2b) As EH Directors' attitudes towards climate change become more negative, their perceptions of the risk posed by climate change increases.

H2c) As EH Directors' attitudes towards climate change action become more positive, their behavior in addressing climate change within their department increases.

H2d) As EH Directors' risk perceptions increase, their behavior in addressing climate change within their departments increase.

H2e) As EH Directors' response efficacy increases, their behavior in addressing climate change within their departments increase.

H2f) As EH Directors' views on their department's efficacy increases, their behavior in addressing climate change within their departments increase.

H2g) As EH Directors' perceived responsibility increases, their behavior in addressing climate change within their departments increase.

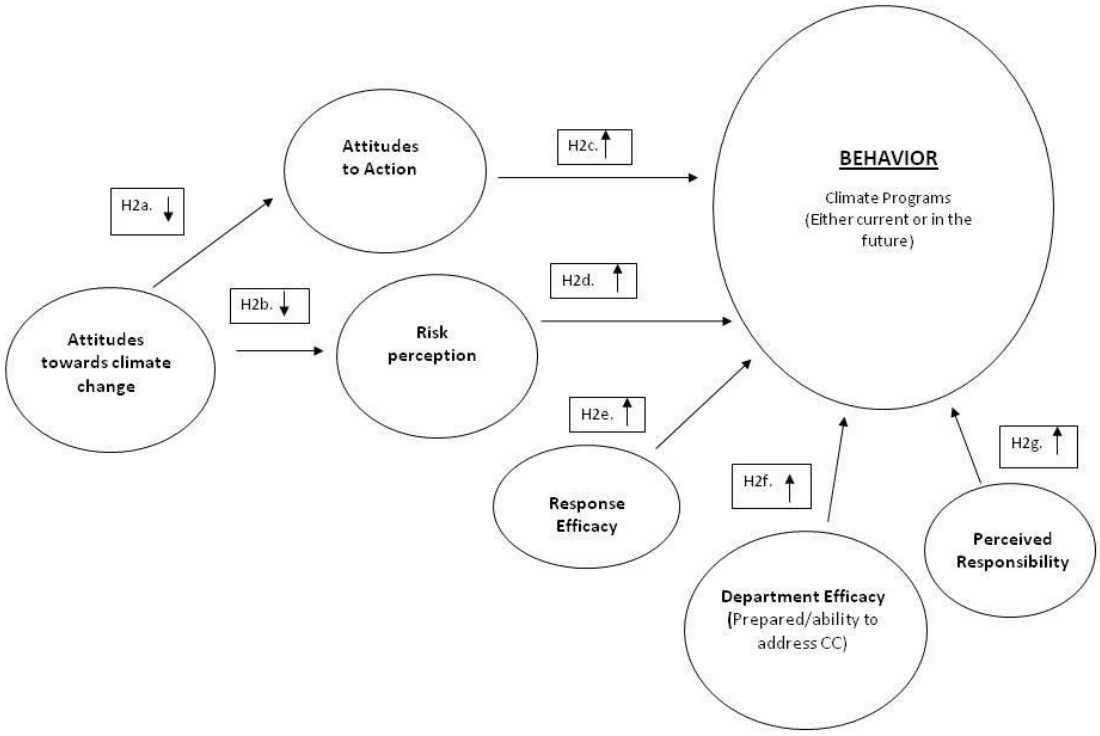

Figure 3.2: Hypothesized correlations (where an arrow pointing up conveys a positive correlation while an arrow pointing down conveys a negative correlation) and independent variables expected to directly influence behavior in the regression model

3.4 Developing the survey

Many questions from the first draft of the project's questionnaire were taken from the 2005 NACCHO "Are We Ready Yet?" survey (Balbus, et al., 2008). In order to get outside opinions on the first draft of the questionnaire, as well as on the research project as a whole, two focus groups were conducted. The first focus group consisted of eight Ohio Public Health Nursing Directors, while the second group consisted of two Ohio Environmental Heath Directors from either a city or county health department, and one administrator from a city health department. The focus groups gave valid opinions

about the overall topic of the research project. For example, the participants explained that climate change is an emerging issue, so it is hard to get all of the staff members to agree on the relative seriousness of climate change. The focus groups also identified several important problems with the survey, such as questions that were unclear or unnecessary. Many of the participants also felt that the survey was too long. As a result, some of the NACCHO survey questions were eliminated to shorten the length of the survey, so that it would only require approximately fifteen minutes of the respondent's time.

The final draft of the survey (Appendix A) contains additional modified questions from different sources. Approximately eight different versions of the survey were developed before the final version was implemented in an online survey system (Checkbox). Before releasing the survey to EH Directors, a research lab at The Ohio State University – consisting of faculty and graduate students – took the online survey. After taking the survey, the class had a thirty-minute discussion on how long the survey took, and whether or not the survey questions and responses looked correct through the online system. The class also addressed any questions that were confusing, and suggestions were made on proper revisions. The final survey consisted of fourteen pages, including an introduction and conclusion page thanking respondents for their time and input (see Appendix A).

The survey questions measure the project's key independent variables, as well as the two dependent variables (i.e., attitudes towards climate change and EH Department climate change adaptation behavior); the questions will help identify

existing correlations between the different variables. Several questions were slightly modified in order to more appropriately fit the study's focus on climate change and human health. The measures for each variable and their various sources are discussed in further detail in the following section.

3.4.1 Measures

Socio-demographics – At the end of the survey, there were several questions that ask about specific socio-demographics, such as the respondent's location, age, level of education, gender, and political ideology, in order to assess differences across these categories. Most of the socio-demographic questions came from the NACCHO survey (Balbus, et al., 2008). However, the political ideology question, which asked respondents to indicate their political views on a scale of extremely conservative to extremely liberal, was taken directly from Kellstedt, et al. (2008). The education, political ideology, and gender questions in the socio-demographic section will help test hypotheses H1a – H1e, which state that EH Directors who are more educated will have more knowledge about the health-related impacts of climate change, and that EH Directors who are more politically liberal and female will have a more positive attitude towards the environment, and a more negative attitude towards climate change.

Knowledge – Knowledge was measured by self-reported data; respondents were asked to rate their current knowledge about the potential health-related impacts of climate change on a scale of 0 (no knowledge at all) to 10 (complete knowledge), and to rate where they think their knowledge should be about these health-related impacts, using the same type of scale (Figure 3.3). Self-reported knowledge was used in the survey,

because where individuals think their knowledge is and where they think it should be helps indicate the degree to which people seek out information to fill perceived gaps in knowledge; these modified questions were taken from Kahlor (2007). The self-reported knowledge measure will help test hypothesis H1f, that individuals with greater knowledge will have more negative attitudes towards climate change.

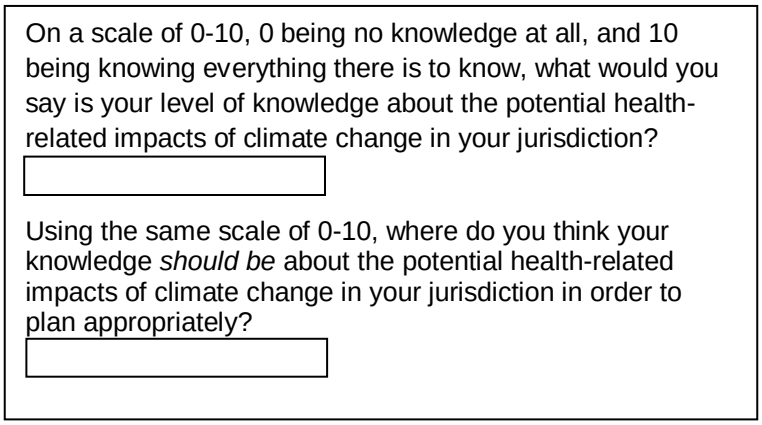

Figure 3.3: Measure of self-reported rank of current knowledge and where knowledge should be

Attitudes towards the environment – The statements in the survey that assess EH Directors' attitudes towards the environment were taken from Dunlap and Van Liere's New Environmental Paradigm scale (Dunlap, 1978). Although the NEP Scale contains fifteen statements, only eight were used in the survey (Figure 3.4). In order to diversify the responses, four NEP statements worded positively towards the environment and four NEP statements worded negatively towards the environment were selected. Respondents were asked to indicate to what extent they agreed or disagreed with each statement on a 7-point Likert scale, where -3 = strongly disagree and 3 = strongly agree. The NEP measure will help test hypothesis H1g, that individuals with a more

positive environmental attitude will have a more negative attitude towards climate change.

Please indicate to what extent you agree or disagree with each statement
(where -3 = strongly disagree (SD), -2 = somewhat disagree, -1 = mildly disagree, 0 = neither agree nor disagree (N), 1 = mildly agree, 2 = somewhat agree, and 3 = strongly agree (SA)).

	SD			N			SA
	-3	-2	-1	0	1	2	3
We are approaching the limit of the number of people the earth can support.	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs.	○	○	○	○	○	○	○
When humans interfere with nature it often produces disastrous consequences.	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them.	○	○	○	○	○	○	○
Plants and animals have as much right as humans to exist.	○	○	○	○	○	○	○
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	○	○	○	○	○	○	○
Humans are severely abusing the environment.	○	○	○	○	○	○	○
Humans will eventually learn enough about how nature works to be able to control it.	○	○	○	○	○	○	○

Figure 3.4: Eight NEP items used in the survey

Attitudes towards climate change – EH Directors' attitudes towards climate change were measured using semantic differential scales. With semantic differential scales, respondents are asked to indicate their position about the object of interest (i.e., climate change) on a scale between two opposite word pairs (Osgood, Suci, & Tannenbaum, 1957). The questions measuring attitudes towards climate change were modified from Kahlor & Rosenthal (2009). Respondents were asked to indicate their position based on a 7-point scale with two opposite attitudinal items (i.e., bad – good, uncontrollable –

controllable) (Figure 3.5). The climate change attitude measure will help test hypotheses H2a and H2b, that attitudes toward climate change negatively correlate with attitudes toward climate change action and perceived risk.

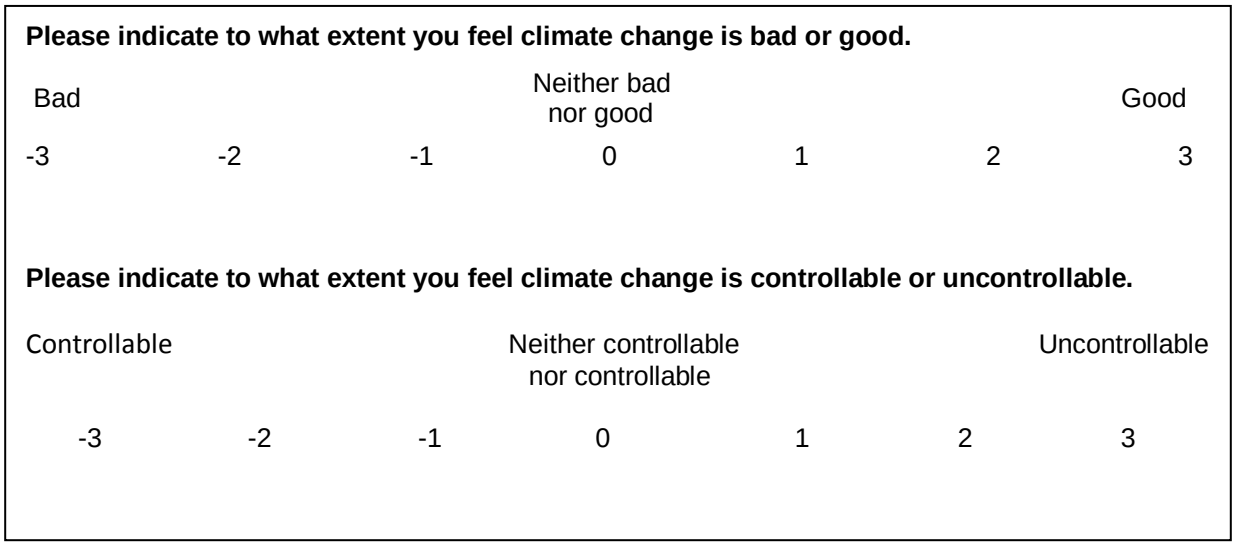

Figure 3.5: Measure of attitude towards climate change

Attitudes to climate change action – The questions assessing EH Directors' attitudes towards behavior, specifically the act of addressing climate change within their department, were also semantic differential scales modified from Kahlor & Rosenthal (2009). Respondents were asked to indicate their position on two attitudinal items (i.e., bad – good, worthless – valuable) (Figure 3.6). This measure of attitude towards climate change action will help test hypothesis H2c, which states that attitudes toward action will positively correlate with behavior.

Please indicate to what extent you feel addressing the potential health-related impacts of climate change through the public health system is bad or good.

Bad			Neither bad nor good			Good
-3	-2	-1	0	1	2	3

Please indicate to what extent you feel addressing the potential health-related impacts of climate change through the public health system is worthless or valuable.

Worthless			Neither worthless nor valuable			Valuable
-3	-2	-1	0	1	2	3

Figure 3.6: Measure of attitude towards addressing climate change

Risk Perception – Whether or not EH Directors perceive climate change as a risk was measured by several items modified from Leiserowitz (2006), relating to concern and expected impacts. Similar to the NEP items, respondents were asked to indicate to what extent they agreed or disagreed with each statement on a 7-point Likert scale, where -3 = strongly disagree and 3 = strongly agree (Figure 3.7). This measure of perceived risk will help test hypothesis H2d, which states that perceived risk positively correlates with behavior.

In order to also look at EH Directors' perception of the risk posed by specific health-related impacts of climate change, statements from the NACCHO survey were also incorporated. Respondents were asked if each of the 12 stated health impacts had increased, or would increase, as a result of climate change. The response choices were either Yes, No, or Don't Know (Figure 3.8).

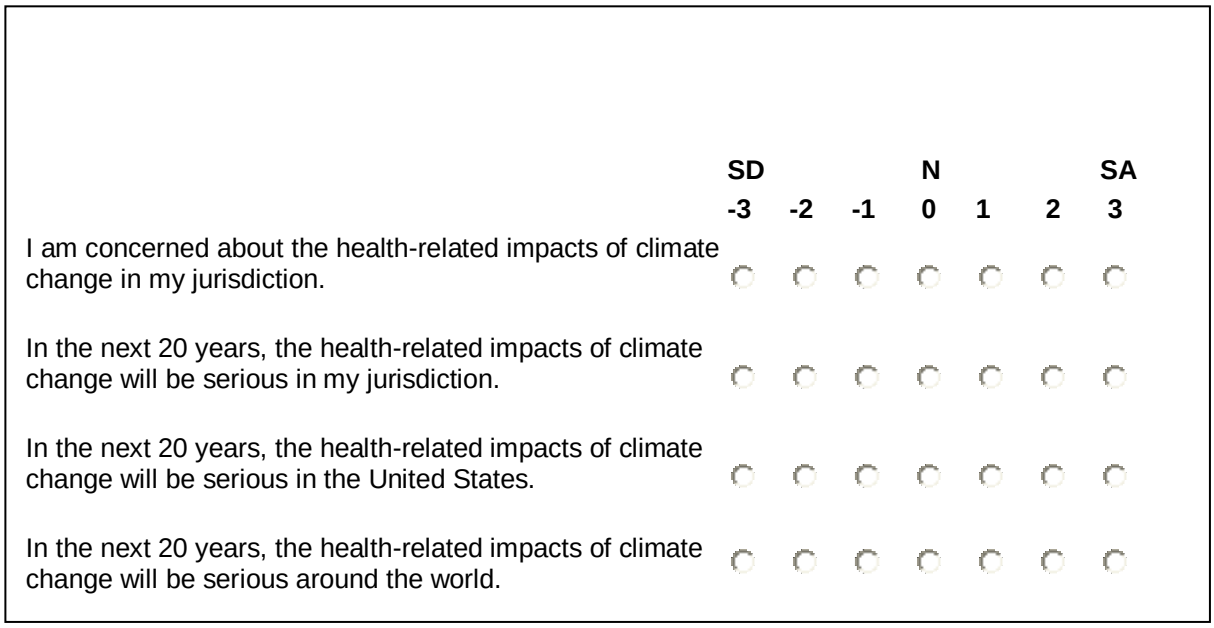

Figure 3.7: Measure of the perceived risk posed by climate change

The following are a list of health-related impacts that may increase as a result of climate change. Please think about whether each of these issues:

	A. Has already increased or will increase within the next 20 years as a result of climate change.		
	Yes	No	DK
Heat-related illness	○	○	○
Flooding-related displacement of residents	○	○	○
Vectorborne infectious disease	○	○	○
Waterborne disease	○	○	○
Foodborne disease	○	○	○
Water availability related illness	○	○	○
Air quality related illness	○	○	○
Malnutrition	○	○	○
Disruption of health care services during extreme weather events	○	○	○
Anxiety, depression or other mental health conditions	○	○	○
Cold-related illness	○	○	○
Other	○	○	○

Figure 3.8: Measure of the perceived risk posed by specific health-related impacts of climate change

Department Efficacy and Response Efficacy – Since efficacy has been shown to influence an individual's behavior, the survey includes statements that analyze an EH Director's view of their department's level of self efficacy as well as response efficacy, in order to test hypotheses H2e and H2f, that efficacy positively correlates with behavior.

The response efficacy statement (Figure 3.9) is modified from the Kellstedt, et al. (2008) article. However, the two statements used as a measure of department efficacy (Figure 3.10) were uniquely developed, with some guidance from the NACCHO survey. Again, respondents were asked to indicate to what extent they agreed or disagreed with each statement on a 7-point Likert scale, where -3 = strongly disagree and 3 = strongly agree.

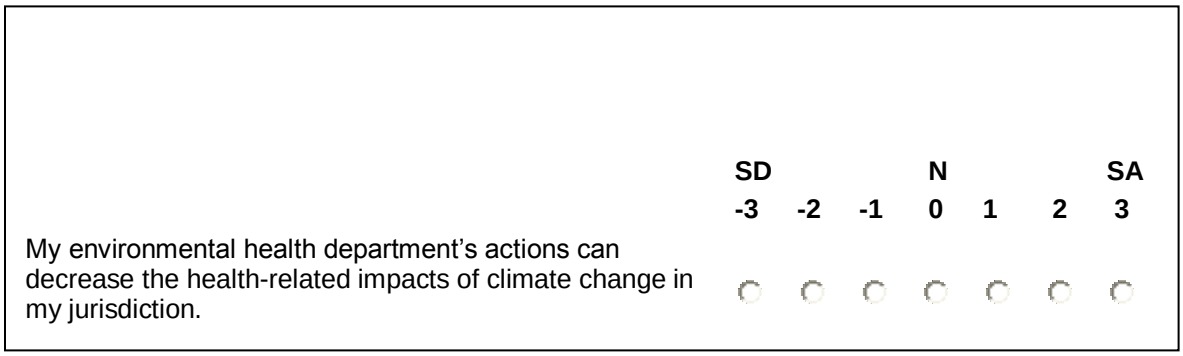

Figure 3.9: Measure of response efficacy

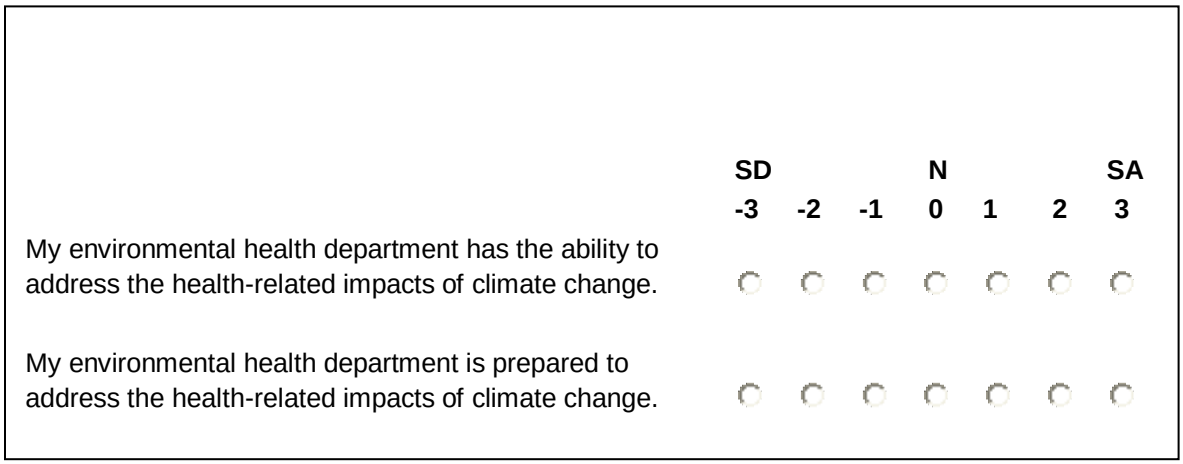

Figure 3.10: Measure of department efficacy

Perceived Responsibility – The statement assessing EH Directors' perceived responsibility of addressing climate change was also uniquely developed. This

statement was developed in order to assess whether or not EH Directors felt that it is their responsibility to address climate change. Respondents were again asked to indicate to what extent they agreed or disagreed with each statement on a 7-point Likert scale, where -3 = strongly disagree and 3 = strongly agree (Figure 3.11). This measure of responsibility will test hypothesis H2g, which states that perceived responsibility positively correlates with behavior.

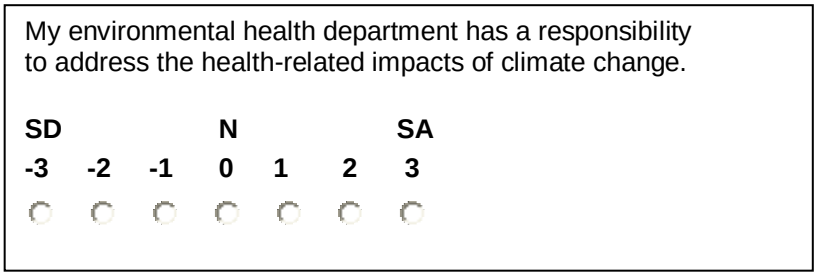

Figure 3.11: Measure of perceived responsibility

Behavior – In order to assess EH Departments' current activity or inactivity in addressing climate change, several statements from the NACCHO survey were added to the project's survey. The matrix of the twelve different health-related impacts of climate change also asks respondents whether or not the specific health impact was a current area of programmatic activity within their health department, or if it would be an area of programmatic activity within the next five years (Figure 3.12).

The following are a list of health-related impacts that may increase as a result of climate change. Please think about whether each of these issues:

	B. Is currently, or soon will be, an area of programmatic activity in your EH department.		
	Yes	No	DK
Heat-related illness	○	○	○
Flooding-related displacement of residents	○	○	○
Vectorborne infectious disease	○	○	○
Waterborne disease	○	○	○
Foodborne disease	○	○	○
Water availability related illness	○	○	○
Air quality related illness	○	○	○
Malnutrition	○	○	○
Disruption of health care services during extreme weather events	○	○	○
Anxiety, depression or other mental health conditions	○	○	○
Cold-related illness	○	○	○
Other	○	○	○

Figure 3.12: Measure of the programmatic activity for specific health-related impacts of climate change

Outside barriers to behavior – To further understand current climate change activities within an EH Department, an open-ended question was added at the end of the survey. The question asks respondents to list up to three resources that their EH Department

needs in order to improve their ability to address climate change; some suggestions stated within the question included funding, staff, and training (Figure 3.13).

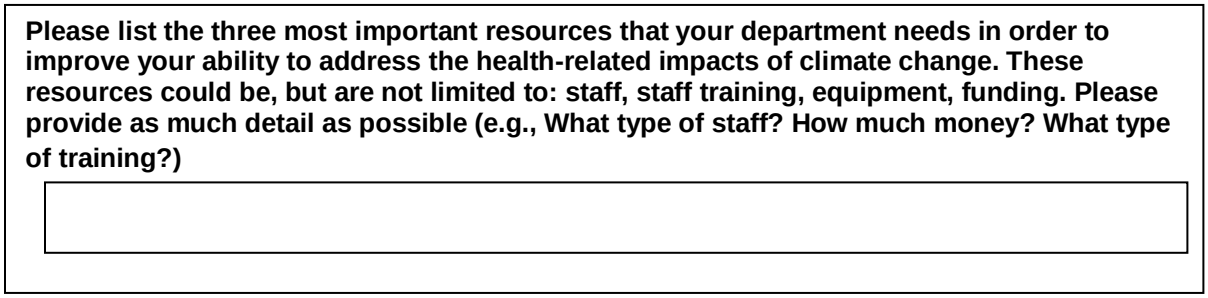

Figure 3.13: Open-ended statement about resource needs

3.5 Implementing the survey

The survey was distributed via e-mail to all of the known EH Directors across the country. The process of releasing the survey was based on Dillman's Tailored Design Method (Dillman, 2007). A pre-notice letter was e-mailed to the survey population on March 15, 2010, informing respondents about the survey. On March 17, 2010, the survey was initially sent out, with a first reminder e-mailed on March 24, and the second reminder sent on March 31. The closing date of the survey was April 13, 2010.

3.6 Data Collection and Analysis

After the survey's closing date, the responses were collected and exported into Microsoft Excel. Once the variables were labeled correctly, the Excel spreadsheet was transferred to SPSS 17.0 (Pallant, 2005). After running reliability tests for the measures with more than one survey question, descriptive statistics were run for each measured variable. Also, Pearson's correlations were run in order to test the hypothesized relationships. Finally, regression analyses were conducted in order to analyze to what degree the independent variables in each model predicted changes in the dependent

variables (i.e., multiple regression analysis for the attitude model and logistic regression analysis for the behavior model). Only those independent variables hypothesized to directly influence the dependent variables (as opposed to indirectly) were included in the regression analyses.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Reliability Testing

The 8 combined items for environmental attitudes had a Cronbach's alpha of 0.783. Since the Cronbach's alpha coefficient was above 0.7, the 8 items were used as a measure of environmental attitudes (Pallant, 2005). However, for the first dependent variable (i.e., attitudes towards climate change), it was found that the two semantic differential scales (i.e., bad – good, uncontrollable – controllable) had a Cronbach's alpha of 0.651 when combined as one measure of climate change attitude. Since this result was less than 0.7, only the bad – good scale was used as the final measure of climate change attitudes.

The two combined items for attitudes to action had a Cronbach's alpha of 0.795. The four combined items used as a measure of risk perception had a Cronbach's alpha of 0.957. Finally, the two combined items for department (self) efficacy had a combined Cronbach's alpha of 0.790. As a result, the combined items for these variables were used as a measure of attitudes to action, risk perception, and department (self) efficacy.

4.2 Descriptive Results

The descriptive results for each variable tested (except socio-demographics) are described in more detail in Tables 4.1 and 4.2 below.

	n[a]	M	% Low	% Neutral	% High
Knowledge[b]	208	5.39	30	25	45
Risk perception[c]	208	0.42	30	4	66
Response efficacy[c]	206	-0.54	47	19	34
Department efficacy[c]	206	-1.06	66	15	20
Perceived responsibility[c]	206	-0.02	37	15	48
Behavior[d]	262	0.43	57	-	43

[a] With a sample of 206 and confidence level of 95%, the margin of error for these estimates is +/- 5.92% - 6.52%[2]
[b] Measured on a scale where 0 = know nothing about climate related health impacts, 10 = know everything about climate related health impacts
[c] Measured on a scale where -3 = low risk/efficacy/responsibility, 3 = high risk/efficacy/responsibility
[d] Measured as a dichotomous variable where 0 = no climate change programs, 1 = climate change program(s)

Table 4.1: Descriptive results for knowledge, risk perception, efficacy, perceived responsibility, and behavior indicating the total sample size, mean response, and percent of responses classified as low, neutral or high

[2]Margin of error range is due to the fact that the exact population of EH Directors is unknown. The lower margin of error is when the sample size = the number of e-mails sent (823 e-mails); the higher margin of error is when the sample size = the approximate number of public health departments in the country (~ 2,353 departments)

	n[a]	M	% Negative	% Neutral	% Positive
Environmental attitudes[b]	220	0.5807	30	5	66
Attitudes to climate change[b]	214	-1.05	58	38	3
Attitudes to action[b]	207	0.7923	20	14	66

[a] With a sample of 206 and confidence level of 95%, the margin of error for these estimates is +/- 5.92% - 6.52%[3]

[b] Measured on a scale where -3 = negative attitude, 3 = positive attitude

Table 4.2: Descriptive results for the measured attitude variables indicating the total sample size, mean response, and percent of attitudes classified as negative, neutral or positive

Of the responses received, 73% were males, while the remaining 27% were females. The majority of respondents' highest level of education was a Bachelor's degree. Specifically, 58.6% of Environmental Health (EH) Directors had a Bachelor's degree, while 34.9% had a Master's degree, and 2.7% has a Doctoral/Professional degree; only 3.8% of respondents had less than a Bachelor's degree. Regarding political ideology, 39% of respondents indicated that they had conservative political views, 29.4% identified themselves as having liberal political views, and 31.6% held moderate political views. The mean score for political ideology of 3.82, on a scale of -3 to +3, indicates that most respondents lie somewhere between slightly conservative to moderate.

[3] Margin of error range is due to the fact that the exact population of EH Directors is unknown. The lower margin of error is when the sample size = the number of e-mails sent (823 e-mails); the higher margin of error is when the sample size = the approximate number of public health departments in the country (~ 2,353 departments)

A slight majority of respondents reported their knowledge about climate change and its health impacts to be between 0 – 5. When looking at the difference between where respondents felt their knowledge about the health-related impacts of climate change should be, minus where their knowledge currently was, the results indicated that 77.9% of respondents felt that they needed to know more than they currently do. On the other hand, 18.3% of respondents felt that they didn't need to know any more about the health-related impacts of climate change, while 3.9% felt that they needed to know less than they actually do.

The majority of respondents had a slightly positive environmental attitude, on a scale from -3 (i.e., completely negative environmental attitude) to + 3 (i.e., completely positive environmental attitude) (Table 4.2). Only one respondent indicated a completely negative environmental attitude. Regarding the first dependent variable, the majority of respondents had a slightly to moderately negative view of climate change, on the same type of scale from -3 to +3 (Table 4.2).

The majority of respondents also had a slightly positive attitude towards addressing climate change within their department, on a scale from -3 to +3 (Table 4.2). Regarding risk perception, the majority expressed that the health-impacts of climate change posed a risk. As Table 4.1 indicates, the average response was a slight belief in the health-related impacts of climate change posing a risk (M = 0.42).

However, a slight majority of respondents demonstrated a lower response efficacy in being able to decrease the health-related impacts of climate change; specifically, 46.6% of respondents indicated little response efficacy. The majority of

respondents demonstrated a more negative belief in their department's ability and preparedness to address climate change (i.e., lower department efficacy); specifically, 65.5% of respondents indicated low department efficacy. Regarding perceived responsibility, the mean score was -0.02, which is very close to neutral. However, when just looking at respondents with low perceived responsibility and high perceived responsibility, a majority of respondents believed their department had some sort of responsibility in addressing the health-related impacts of climate change.

The final dependent variable, current/future climate change adaptation behavior of the EH Department, was measured by matching each individual health impact that the respondent stated would increase due to climate change (refer to Figure 3.8), with whether or not that specific impact was an area of programmatic activity within their EH Department (refer to Figure 3.12). It was assumed that if the individual believes the specific health impact will increase due to climate change, and their department addresses or plans to address the impact, then climate change would be taken into consideration when addressing the health impact within their department. Respondents were then given a 0 if they had no climate change adaptation programs, or a 1 if one or more programs did exist/would exist in the future. Using this measure, a slight majority of respondents are doing nothing to address the specific health impacts in the context of climate change. However, when looking at the number of programs individually, a large majority of EH Departments were only addressing between 0 – 3 of the health-related impacts in the context of climate change (80%). Only 8 departments (3.1%) were addressing 8 or more of these impacts in the context of climate change.

Several other responses that were not included in the project's model were also analyzed. For example, the study also looked at whether climate change was a priority within each individual's EH Department. On a scale of -3 to +3, where -3 indicates that climate change is not a priority, and +3 indicates that climate change is a priority, the mean score was -1.53. Specifically, 73.7% of respondents stated that climate change was not a priority in their department, while 11.6% stated that it was a priority.

When looking at the climate change risk perception measure, three of the four items suggest that climate change will pose a risk either at the local, national, or global level. The frequencies for each of these items were run, and it was found that a higher majority of respondents felt that the health-related impacts of climate change would affect the world, as opposed to locally or nationally. Specifically, 36.3% of respondents believed that the health-impacts of climate change would be serious in their jurisdiction, 44.2% felt that it would be serious in the United States, while 51.2% indicated that it would be serious in the world.

Also, when analyzing the respondents' belief in the individual health-related impacts of climate change affecting their jurisdiction (refer to Figure 3.8), 22.1% responded "No" to 10 or more of the impacts listed (i.e., 10 or more of the impacts listed have not and will not increase as a result of climate change within the next 20 years). At the same time, 5% responded "Don't Know" to 10 or more of the impacts listed (i.e., for 10 or more of the impacts listed, the respondent did not know if each impact has increased or will increase as a result of climate change within the next 20 years).

The open-ended question that asked EH Directors to list three resources needed in order to address climate change (refer to Figure 3.13) was also analyzed. Here, 48.2% of respondents indicated that they would need more funding, especially for additional staff, training, equipment, and resources, in order to address the health-related impacts of climate change. Similarly, 47.1% indicated that they would need additional training, such as training on climate change impacts, Geographic Information System (GIS) software, and community outreach. Another resources needed was staff, with 43% of respondents expressing a need for additional staff members, such as an Environmental Health Sanitarian, Public Health Educator, or climate change specialist. Also, 22.5% of respondents indicated that they needed more information and education on the health-related impacts of climate change.

4.2 Correlations

As an initial test of the project's hypotheses, and as justification for testing the combined and relative strength of the independent variables for predicting attitudes towards climate change and EH Department climate change adaptation behavior, correlations between all of the independent and dependent variables were run. The correlations between the independent variables and their predicted relationships to other independent variables, and/or to attitudes towards climate change are shown in Figure 4.1. Figure 4.2 shows the correlations between the independent variables and their predicted relationships to other independent variables and/or to climate change adaptation behavior within an EH Department. A moderate to strong correlation was defined as higher than +0.3, or lower than -0.3, on a scale of -1 to +1 (Cohen, 1988).

Refer to Appendices B and C for the model correlations in tabular format, and Appendix D for a correlation matrix of all of the variables measured within the study.

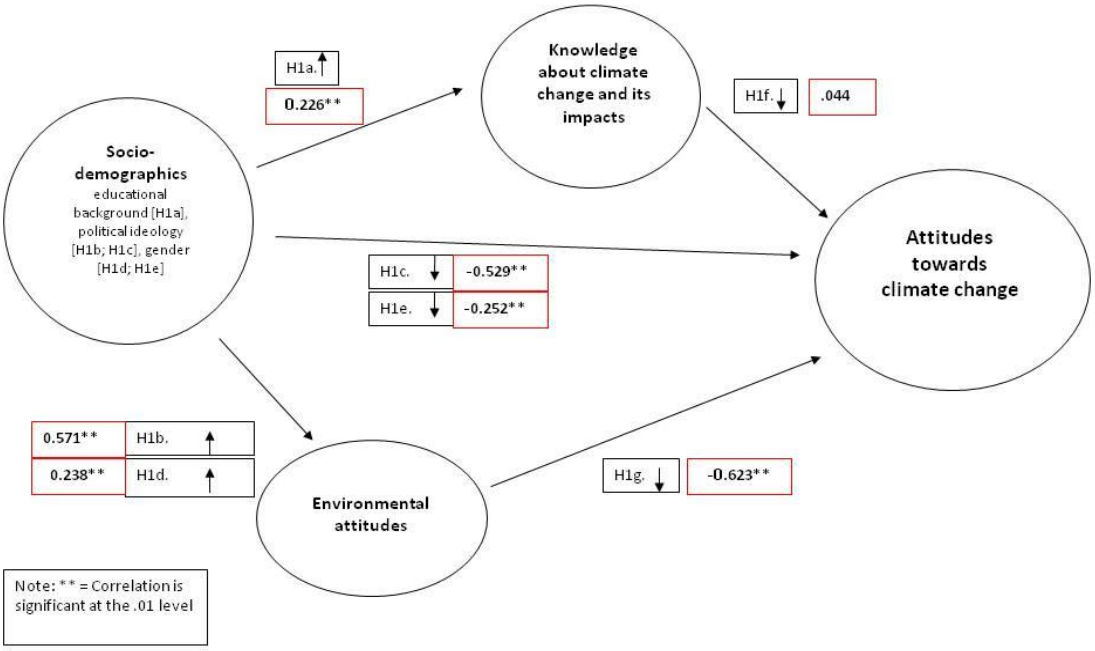

Figure 4.1: Pearson's correlations for the hypothesized relationships regarding attitude towards climate change

This initial correlation analysis provides support for the entire first set of hypotheses, except hypothesis H1f, which stated that the more knowledge an EH Director had about climate change and its health impacts, the more negative their attitude towards climate change. Also, there were several weak correlations. For example, the gender hypotheses (H1d and H1e) were weakly supported by the correlation analysis, although the correlations were significant at the 0.01 level.

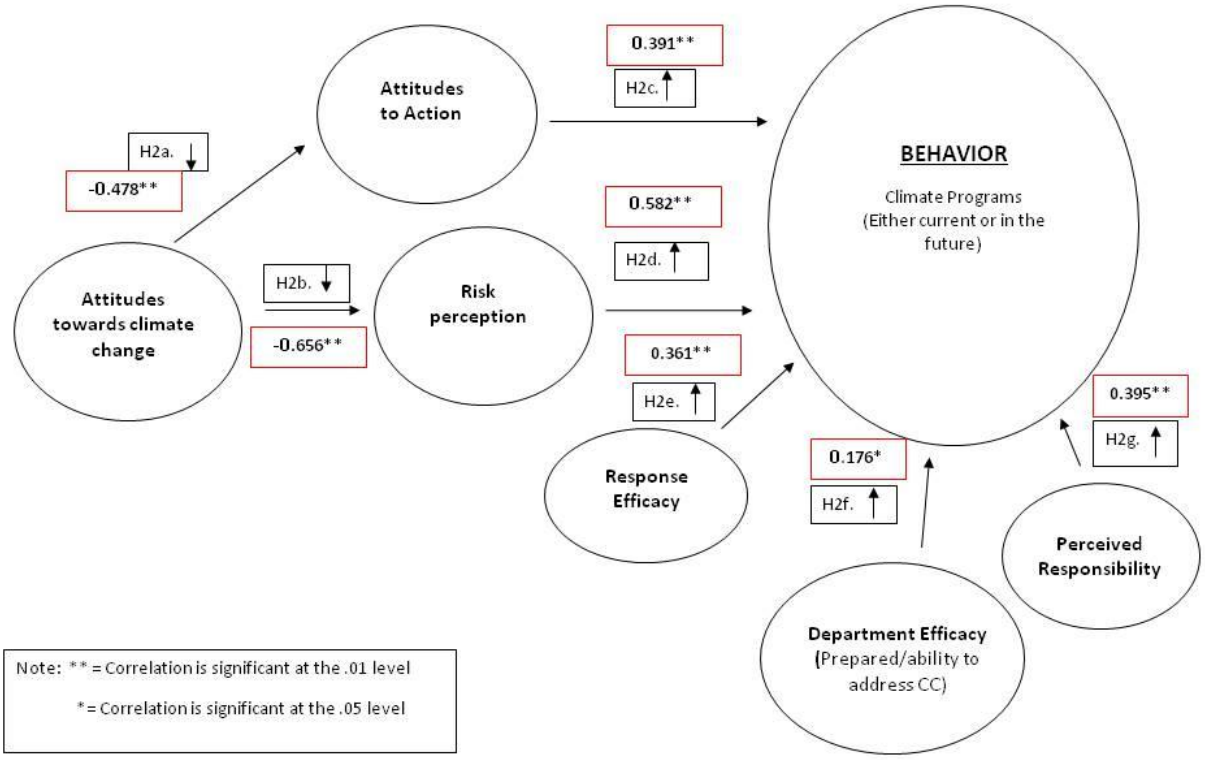

Figure 4.2: Pearson's correlations for the hypothesized relationships regarding climate change behavior within an EH Department

The initial correlation analysis provides support for all of the second set of hypotheses. However, department (self) efficacy was weakly correlated with climate change behavior within the EH Department, with a correlation value of +0.176. The remaining variables support the hypotheses and have moderate to strong correlations, although risk perception clearly exhibited the highest correlation with behavior.

4.3 Multiple regression model for attitude towards climate change

It was expected that gender, knowledge, political ideology, and environmental attitudes would predict a significant amount of the variance in attitude towards climate

change. However, the predictors that had a weak relationship with the dependent variable, a correlation lower than +0.3 or higher than -0.3, were not included in the final model. As a result, knowledge was taken out of the regression analysis because of its weak correlation to attitude towards climate change; however, gender was still kept in the regression model as another socio-demographic measure other than political ideology. No other independent variables exhibited a weak correlation with attitudes towards climate change, nor did any independent variable have an exceedingly high correlation with any other independent variable, which was considered to be a correlation above 0.7 (Pallant, 2005). Also, the Tolerance level, which is an indicator of how much of the variability of each independent is not explained by the other independent variables in the model, was well above 0.1 for all of the variables, indicating a low multiple correlation between the independent variables. This is also supported by the VIF value (Variance Inflation Factor), which is well below the cut-off of 10. Also, there were no significant violations found for normality, residuals, or outliers.

The regression analysis found that the variables included in the model – political ideology, gender, and environmental attitudes – explained 42.6% to 43.6% of the variance in climate change attitudes. The lower percentage of 42.6% is the adjusted R^2 value, which corrects the R^2 value to provide a better estimate of the true population value when a smaller sample is involved. The model was also found to be statistically significant, with $p = 0.000$. When looking at the independent variables separately, political ideology and environmental attitudes were found to be significant predictors in explaining the variance in climate change attitudes, not gender (Table 4.3).

Model	Standardized Coefficients		95.0% CI for B		
	Beta	**Sig.**	**Lower Bound**	**Upper Bound**	**Partial Correlations**
Environmental attitudes	-.471	.000	-.641	-.349	-.457
Gender	-.060	.325	-.494	.165	-.075
Political ideology	-.240	.001	-.318	-.081	-.247

Table 4.3: Results of the multiple regression model for climate change attitude

As the table indicates, it was found that environmental attitudes made the strongest, statistically significant, and unique contribution to explaining attitudes towards climate change, when the variance explained by the other variables is controlled for (-0.471, $p = 0.000$). Political ideology also made a significant unique contribution (-0.240, $p = 0.001$). As the table shows, gender did not make a significant unique contribution to the prediction of climate change attitudes ($p > 0.05$). The data was further analyzed by looking at part correlation coefficients, which explain how much of the total variance in climate change attitudes is uniquely explained by each independent variable, and how much R^2 would drop if it wasn't included in the model. It was found that environmental attitudes uniquely explained 14.9% of the variance in climate change attitudes, political ideology uniquely explained 3.65% of the variance in climate change

attitudes, and gender uniquely explained only 0.325% of the variance in climate change attitudes.

4.4 Logistic Regression model for climate change adaptation behavior

Since the data on programmatic activity was significantly skewed to the left, with the majority of respondents doing nothing to address climate change, it was more appropriate to use logistic regression for the climate change adaptation behavior model, as opposed to a multiple regression analysis. As stated earlier, the dependent variable, which ranged from 0 – 12, was recoded as a categorical dependent variable. The EH Departments that had done nothing to address the health impacts of climate change were given a 0, and those that had at least one climate change program within their department were given a 1.

It was expected that attitudes towards action, perceived risk, department (self) efficacy, response efficacy, and perceived responsibility would predict a significant amount of the variance in behavior. Once again, the correlations with a weak relationship with the dependent variable, less than +0.3 or higher than -0.3, were removed from the binary logistic regression; as a result, department efficacy was not included. Since no other independent variables exhibited a weak correlation with climate change behavior, or an exceedingly high correlation of above 0.7 with another predictor, the remaining independent variables hypothesized to directly influence EH Departments' climate change behavior were kept in the analysis.

The model passed the Omnibus Tests of Model Coefficients, (Chi-square = 84.18, df = 5, p = 0.000). The model also passed the Hosmer and Lemeshow

Goodness of Fit Test (Chi-square = 8.43, p = .392).[4] The model was found to explain 33.8% – 45.2% of the variance in climate change behavior (Cox & Snell R^2 = 0.338 and Nagelkerke R^2 = 0.452). The model also correctly classified 79.4% of cases overall, an improvement over the 54.4% predicted in Block 0, which did not include the predictor variables.

The sensitivity of the model was 86.5%; this means that the model correctly classified 86.5% of the departments who have addressed climate change to some extent. The specificity of the model was 71%, which means that the model correctly classified 71% of the departments who do not have any climate change programs. Table 4.4 indicates that the only variable in the model actually predicting climate change adaptation behavior was risk perception (Wald = 24.847, p = .000, Exp(B) = 2.279). The Exp(B) value is an odds ratio; as a result, the table indicates that the odds of a department addressing climate change is 2.279 times higher for every additional unit of increase in perceived risk of climate change by the EH Director. The 95% Confidence interval for the Exp(B) value was 1.649 – 3.151; since the confidence interval does not contain the value of 1, the result is statistically significant at p < .05.

[4] For the Hosmer and Lemeshow Test, a significance value of < .05 indicates poor fit.

	B	S.E.	Wald	df	Sig.	Exp(B)
Risk perception	.824	.165	24.847	1	.000	2.279
Perceived responsibility	.142	.125	1.287	1	.257	1.153
Response efficacy	-.006	.142	.002	1	.969	.995
Attitudes to action	.080	.158	.253	1	.615	1.083

Table 4.4 Results of the logistic regression model for climate change behavior

4.5 Discussion

The objective of this study was two-fold. First, the study aimed to identify the factors believed to influence attitudes towards climate change. Second, the study aimed to identify the factors believed to influence the climate change adaptation behavior of an EH Department. Most of the hypotheses were confirmed with significant correlations, except for the correlation between knowledge and climate change attitudes (Hypothesis h1f). Knowledge may not explain attitudes towards climate change in this study because the survey asked for self-reported knowledge, as opposed to assessing true knowledge. As a result, the data for knowledge could be somewhat inaccurate, and respondents could have had more or less knowledge than what they indicated.

Among the socio-demographics, weak correlations were found between gender and environmental attitudes (hypothesis H1d), gender and climate change attitudes (hypothesis H1e), and education and knowledge about the health impacts of climate change (hypothesis H1a). However, it is important to note that there is a considerable amount of literature supporting the fact that gender influences attitudes towards the

environment and climate change (Diamantopoulos, et al., 2003; Kollmuss & Agyeman, 2002; Leiserowitz, 2007). The weak correlation between education and knowledge could be attributed to the fact that climate change was not a part of the respondent's higher education curriculum.

A weak correlation was also found between department (self) efficacy and climate change adaptation behavior within EH Departments (hypothesis H2f). A possible explanation for the weak correlation could be that even if a department is able and prepared to address climate change, other barriers may get in the way of action. For example, if a department lacks sufficient funding, they may not be able to incorporate climate change programs, even if they feel they have the training and expertise to address climate change. Or, departments may exert a low response efficacy, meaning that they don't address climate change because they don't feel like their actions can make a difference, even if they are prepared and able to address it.

This explanation can also help to explain why, after running a logistic regression, attitudes to action, response efficacy, and perceived responsibility were not significant factors for explaining behavior; even if a department feels like they should address climate change, thinks their actions can make a difference, and believes it's their responsibility to do so, they may be held back by outside constraints, such as funding, training, or staff. Since risk perception was shown to be the biggest factor that explained behavior in the logistic regression, another possible explanation could be that many of the EH Directors who were not taking action did not perceive climate change as a localized and current risk that needs to be addressed.

After running a multiple regression on the model for attitudes towards climate change, environmental attitudes and political ideology were found to be significant predictors in explaining the variance in climate change attitudes. Previous research confirms that environmental attitudes and political ideology influence attitudes towards climate change. As explained in Chapter 2, Dunlap, et al. (2000) states that people who receive a high NEP score also have similar attitudes towards specific environmental issues, such as global climate change. Similarly, the Leiserowitz (2007) study found that respondents who expressed anti-environmental attitudes predominantly perceived climate change as a very low or non-existent danger. Additionally, the study found that those who thought climate change was a serious issue were mainly politically liberal. It has also been found that politically liberal individuals often have a significantly higher pro-environmental rating on the NEP Scale as well (Slimak & Dietz, 2006).

This study also parallels the Leiserowitz (2007) study in that risk perception was found to be a significant (and in this case the only significant) factor influencing behavior. This finding is also supported by O'Connor, Bord, & Fisher (1999). As Leiserowitz explains, if Americans do not begin to view climate change as a current, local threat that can affect them in some way, then the risk will not fully be perceived, and climate change will remain a low priority (2007). Similarly, a different article on the same Leiserowitz study describes the differences between perceived geographical risks that were also found in this study. Just as the Leiserowitz study showed that the majority of Americans perceived climate change as a moderate risk that would mainly impact other, distant geographical locations (Leiserowitz, 2005), this study found that

more respondents felt climate change was a risk to the world, as opposed to a risk to our nation or their local jurisdiction.

When comparing the results of this study to the two previous surveys by NACCHO and ASTHO, it is clear that significant progress has not been made. In the NACCHO survey, only 19% of respondents indicated that climate change was among their department's top 10 current priorities (Balbus, et al., 2008). In the ASTHO survey, 23% of respondents considered climate change to be one of their agency's top ten priorities (Trust for America's Health, 2009). Although this study did not ask EH Directors if climate change was one of their department's top ten priorities, the survey did ask respondents if climate change was generally a priority within their department; only 11.6% stated that it was a priority within their EH department.

When looking at the survey data and comparing results, the majority of respondents felt that they needed to know more about climate change, but had a positive attitude towards addressing climate change within their department. Also, a slight majority of respondents indicated that they had a responsibility to address climate change, and the majority perceived climate change as a risk. However, a slight majority of respondents demonstrated lower response efficacy in being able to decrease the health-related impacts of climate change, and lower department (self) efficacy as well. These results indicate that although EH Directors expressed that they wanted to know more about the health-related impacts of climate change, perceived it as a risk, and wanted to address climate change, many don't feel they can make a difference and/or don't feel prepared and able to address the health impacts of climate change.

For EH Directors that don't perceive climate change as a risk, education and further research on the extent and timing of local health impacts is needed. Since approximately 22% of respondents said "No" to 10 or more of the specific health-related impacts that are believed to increase due to climate change (refer to Figure 3.8), it is evident that more information on climate change impacts, as well as more outreach to public health professionals on these impacts, is needed in order for EH Departments to properly prepare their jurisdiction for climate change.

Although attitude towards climate change was highly correlated with risk perception, it is difficult to influence an individual's political ideology and/or attitudes towards the environment, since these attitudes are closely tied to one's political ideology and potentially static value orientations. However, it is important to frame climate change as a non-partisan issue within the context of human health, when trying to influence EH Directors' attitudes towards addressing climate change, perceived risk, and ultimately department behavior. Similarly, for EH Directors that exhibit low efficacy, training materials and tool kits on how to properly address climate change should be developed and communicated to EH Departments.

For EH Directors that already possess these internal factors but are not addressing or planning to address climate change, outside resources are needed, especially increased funding; since almost half of the respondents indicated a need for more funding and training, this was found to be a significant barrier to behavior, similar to the NACCHO and ASTHO findings. Since it is clear that more research needs to be done on the exact extent and timing of the projected health impacts of climate change,

funding is needed in order to help answer these questions. Funding would also help provide expertise, training, needs assessments for jurisdictions, response plans, and community outreach, all of which would allow EH Departments to properly address the expected health impacts of climate change within their jurisdiction (Trust for America's Health, 2009).

There were several strengths and limitations of this study. For the most part, the study had valid and reliable measures for the different variables analyzed. However, since there were so many departments doing nothing to address climate change, the skewed results made multiple regression analysis impossible for the behavior model. As a result, because logistic regression was used, the variation in the number of climate change programs between different departments was lost. Another limitation to this study was that the small sample size prevented an analysis through structural equation modeling, in which path analysis could have been conducted in order to identify causal relationships among variables (for example, how political ideology influenced behavior). Finally, the small sample size may also call into question the degree to which the results are representative of the larger population of EH Directors in the United States.

Several of these limitations are being addressed by releasing a shorter follow-up survey to the non-respondents. The shorter survey still assesses the essential variables measured within the study. Collecting more data points may strengthen the sample size and allow for structural equation modeling on the main variables of interest.

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